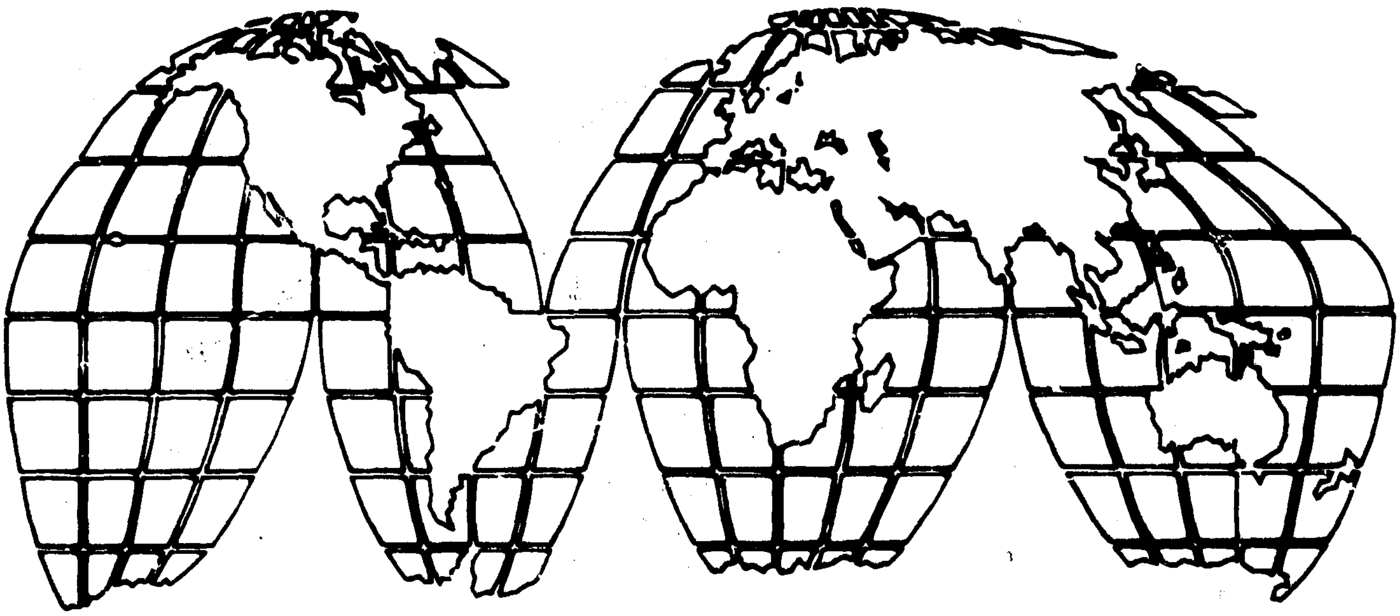
A.I.D. Program Design and Evaluation Methods No. 2.

Selection and Justification Procedures for Rural Roads Improvement Projects



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Selection and Justification Procedures for Rural Roads Improvement Projects

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A.I.D. Program Design and Evaluation Methods Report No. 2

by

Charles G. Vandervoort
(U.S. Department of Transportation)

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PREFACE

This manual was developed by a working group which grew out of the Rural Roads Evaluation Conference, November 1980. One of the recommendations of that conference (summarized in Program Evaluation Report No. 5: Rural Roads Sector Summary) was that guidelines and procedures be developed for selection and justification of rural roads projects. This task was completed by a subcommittee representing the different bureaus in AID (as well as the transport economist from DOT). They should be applauded for taking on this additional responsibility and following through so well. As a footnote to the impact evaluation reports and the sector summary.

These guidelines provide a useful means to choosing among proposed rural roads subprojects. Better decisions about which roads to build will lead to better road projects. As an addition to the impact evaluations and sector summary, this report will achieve the goal of the impact evaluation series of improving the design and implementation of AID projects.

Marion Warren
Marion Kohashi Warren
Chief of Evaluation (Acting)
Office of Evaluation
Bureau for Program and Policy Coordination

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I. SELECTION METHODOLOGY FOR LOCAL RURAL ROADS: INTRODUCTION

The impact evaluations performed by the Agency for International Development (AID) have found that transportation is a particularly important component of rural development. This is especially true for rural roads that provide vitally needed access to markets and social services, stimulate the local economy, increase food production, and help to integrate isolated segments of the rural population into the overall economy. The importance of rural roads has been recognized by AID and other donors, and the trend over the past several years has been increasingly toward investment in rural roads with less emphasis on primary roads. But the impact evaluations have also found that rural roads cannot be justified solely--as was done in the past--on the basis of traditional economic benefits consisting of road user savings and additional agricultural production. Rather, the road selection and justification procedures must include the social implications of the improved rural mobility resulting from the road project. Furthermore, the appraisal of rural road projects cannot be done in isolation but must take into account both the costs and incremental benefits of complementary activities such as investment in agricultural extension.

The need for improved selection and justification procedures for rural roads was one of the issues identified at the AID Rural Roads Conference held at Harper's Ferry, West Virginia in November 1980. It was found that a considerable proportion of AID-sponsored road construction projects had little impact on improving the welfare of the rural population. Many of these roads did not increase travel opportunities or improve agricultural production of small farmers and low-income rural families. Mainly because of inadequate selection and justification procedures, too large a portion of the funds invested in rural roads projects was wasted.

Two important reasons for the inadequate rural road selection and justification procedures used in the past--and still being used at present--are (1) the lack of proven procedures that can be adapted to projects in different countries, and (2) the lack of guidelines on appropriate criteria to apply to a rural roads project.

The lack of a recommended and proven procedure implies that each project preparation team has to invent, practically from scratch, its own approach to selection and justification. Lack of time during the project preparation phase and lack of opportunity to test the procedures result in inadequate selection and justification of the roads.

The lack of guidelines as to which criteria should be applied to road projects means there is no clear-cut guidance on whether or not to include economic or social criteria as factors during the justification. As a result, some projects in the past included formal economic feasibility tests as the only criterion for justification, while other projects applied only social considerations. For those projects where both social and economic factors were considered, the weights applied to the factors were often inconsistent.

The Rural Roads Transportation Working Group was assigned the responsibility, among other things, of remedying this inadequacy and of developing better procedures for selection and justification of rural roads. A subcommittee was formed (Bob Burke, Charles Mathews, Mike de Metre, Charles Vandervoort, and John Zedalis) to initiate the required work. This report represents the result of that work.

The goal was to develop selection and justification procedures that ensure valid identification and ranking of a limited number of good road projects from a longer list of proposed projects.[1] For AID, such projects involve the improvement of small local roads, often called feeder roads or farm-to-market roads (but can include secondary rural roads), and construction of new feeder (penetration) roads. An initial list often contains road projects that are not economically or socially viable and that must be culled out. And, funding limitations usually dictate that only a limited number of the proposed projects can be undertaken.

As an example, under the Kenya Rural Access Roads project, each District Development Committee, assisted by units at lower government levels, would submit a list of from 60 to 90 feeder roads, amounting to a total length of about 800 kilometers (km), to be considered for construction or improvement. But the budget available to the district for a local rural roads work program would often only be enough to improve about 10 of the roads, and selection procedures therefore had to be applied to ensure that only the 10 most critical roads were included in the program.

The selection procedures proposed in this report differ from the traditional economic appraisals in that the latter emphasize primarily the assessment of economic growth and therefore concentrate only on the growth-promoting aspects of a project, such as user cost savings and increases in agricultural surplus. Selection procedures presented here, on the other hand, focus on a broader spectrum of objectives that are

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[1]These procedures could also be adapted for other programs consisting of many small subprojects, such as village water supply or rural electrification programs.

related to rural development as a whole. In addition to economic growth, these objectives include factors relating to economic welfare (income distribution, for example) and social welfare (such as access to health facilities).

Because local rural roads are much less expensive (on a cost per kilometer basis) than higher order roads, the selection procedures for rural roads must be proportionally less costly than those for the other roads. Finally, since local involvement in the selection process is an important consideration in AID-sponsored local rural roads programs, the selection procedures must be applicable by nontechnical personnel at the local level (although expert assistance should be provided when needed).[2] For example, the traditional appraisal procedures described in IBRD Working Papers No. 362 and No. 241 may be too costly for these small roads since they depend on detailed data collection and analysis to determine each road's zone of influence. These procedures also require considerable computerized data processing and special analytical skills, and may be too difficult for local field personnel to apply. Unless the cost of these procedures can be justified by their precision (ability to discriminate between feasible and infeasible roads), and there is no evidence to date that this is true, they may not be appropriate for the selection of rural roads.

The challenge is to develop selection procedures that (1) consider the broad spectrum of objectives related to economic growth, economic welfare, and social welfare; (2) are relatively cheap to apply; and (3) can be applied by nontechnical personnel at the local level. One of the main problems is that past and current procedures have generally been developed on a project-by-project basis with little transfer of the experience gained to other projects, and without monitoring or conducting ex-post evaluations to assess the effectiveness of the procedures used. In other words, little learning took place. Furthermore, the development of sound procedures for a specific project was usually beyond the resources allocated to the project, especially with regard to the complex tasks of developing appropriate factor weights, proxies, or indicators of the economic efficiency of the project, and ways to incorporate considerations of income distribution in the analysis. Finally, many of the project designers were not and still are not certain about vitally important issues such as whether

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[2]The rural roads impact evaluations found that the active involvement of local governments and communities during selection facilitated project implementation and increased the likelihood that the roads would be maintained. Furthermore, local involvement at the planning stage strengthens a community's resource management capabilities.

their selection criteria should include the factor of economic growth, and how it should be included. For example, should it be used as a cut-off criterion such that all roads must, say, have an economic rate of return exceeding 15 percent, or should the internal rate of return be weighted and included with the other considerations?

The aim of this report is to develop procedures for the selection of rural roads that have an acceptable level of reliability, that can be applied at the local level, and that satisfy the following conditions:

1. The procedures must be applicable, after a short training period, by local junior-level staff equipped with limited computational resources, although it may be assumed that they have programmable calculators and know how to use them.

2. The procedures must do more than rank candidate roads; they must also exclude economically infeasible roads.

3. It must be easy for the AID project officer or supervising consultant to monitor the quality of the field data and the calculations going into the selection procedures. Thus, they should be able to discover attempts (perhaps because of political pressure) to select roads by using biased calculations or invented data.

4. The procedures must be efficient in that their total cost of application should be minimized. Total cost is the sum of the actual cost of training people to use the procedures, actual application of the selection procedure (the cost of data collection, etc.), plus the cost of wrongly including nonfeasible roads plus the cost of wrongly excluding feasible roads.

5. The procedures must take into account considerations of economic growth (increased productivity and incomes), economic welfare (income and benefit distribution), and social welfare (access services that meet basic human needs).

II. REVIEW OF SELECTION PROCEDURES USED ON RURAL LOCAL ROADS PROJECTS SPONSORED BY AID AND OTHER DONORS

This section briefly reviews the evolution of road selection procedures used by AID and other donors over the past 10 to 15 years. It includes brief case histories of several AID road projects from the early 1970s up to the present time, an interesting pioneering application of selection procedures as applied and under development by the World Bank on a rural project in Colombia, and an innovative approach to road selection procedures recently developed by the Massachusetts Institute of Technology with possible application to AID road programs. In general, we learn from this review that project designers have already actively searched for better ways to justify and select rural roads, and that encouraging progress has been made during the past decade.

Early in the 1970s, selection of roads was based purely on economic considerations, with little attention being paid to any social impacts the road might have, either adverse or beneficial, and with little involvement by the local government and communities in the selection process. By the mid-1970s, however, more attention was being devoted to the possible social impacts of the roads. A larger proportion of roads that were selected, in addition to serving areas with sufficiently high economic potential, served influence areas that contained a large proportion of the rural poor target beneficiary groups. As a result, the social impact was likely to be favorable. Furthermore, the host governments, especially their local governments, were increasingly involved in the selection and justification process. However, AID and the multilateral agencies involved in rural roads programs have realized that much remains to be done. At the present time there are at least six ongoing large rural roads programs (in the Dominican Republic, the Philippines, Colombia, Kenya, Haiti, and Bolivia, although the program in the last country is in abeyance because of the recent change in government) where new approaches in selection procedures are being tested, refined, and implemented. It is hoped that this report will serve to accelerate the development of improved selection procedures.

A. Liberia Rural Access Roads I and II (AID, Construction Completed in 1975 and 1979)

The selection procedures for these road projects, planned during the early 1970s, were conceived prior to the Congressional mandate of 1974 which specified that AID projects should focus on improving the welfare of the rural poor. In general, these procedures were satisfactory according to the standards of that time, and resulted in the selection of economically viable roads. However, they suffered from a rather narrow focus on economic impacts; they neglected social impacts. The procedures consisted solely of a review by an expert Liberian geographer with considerable road planning experience of a set of road projects proposed by the central Liberian Government. Included were short field inspections of all the proposed road sites to determine the potential for increased agricultural, forestry, and mineral production. To each road, the geographer subjectively assigned points for the determinants of economic feasibility. These determinants included population density along the road, quality of the land, potential for mineral or timber extraction, and cost. The total points for each road were used for ranking, and the top five projects were recommended for implementation. AID and the Liberian Government reviewed and revised these recommendations. No thought was given to what in retrospect turned out to be serious negative social impacts caused by the new roads. These impacts are fully discussed in the AID Liberia Rural Access Roads Impact Evaluation.

B. Jamaica Feeder Roads (AID, Construction From 1972 to 1974)

Construction under this AID project took place from 1972 to 1974 and involved the creation of about 181 miles of all-weather feeder roads. About 5 percent of the work could be classified as the construction of penetration roads, and the remaining 95 percent consisted of rehabilitation and upgrading of badly deteriorated gravel roads. As was customary for road programs initiated prior to the 1974 Congressional mandate, the selection of each road was based purely on the road's economic return. For each subproject, a benefit/cost ratio was calculated based on the value of additional agricultural production plus savings in nonagricultural vehicle operating costs.

Computers were used extensively to assist in data processing and calculations. Roads with a benefit/cost ratio larger than unity automatically became eligible for construction, and construction priority was determined by the level of the road's benefit/cost ratio. Social impact considerations did not play a role in the selection process.

The AID Jamaica Feeder Roads Impact Evaluation report revealed that the economic analysis, though appropriate in conception, had not been executed correctly. Consequently, a large number of economically infeasible roads were constructed. The main reason for the lack of feasibility was overoptimistic estimations of the additional agricultural production that could be expected from road improvement. In addition, design standards and therefore construction costs were raised after the completion of the economic analysis, and no accompanying reanalysis was done to justify the increased costs in terms of increased benefits.

C. Bolivia Rural Roads I (AID, Completed in the Late 1970s)

Selection of the roads for this project was based on a three-stage process consisting of screening, verification of economic and technical feasibility, and ranking on a priority basis. The purpose of the screening was to ensure that each road project satisfied certain minimum conditions: (1) that the road would be connected to an all-weather road, (2) did not exceed 20 km in length (considered to be the maximum length that could be constructed using community labor), (3) served a minimum average farm density of four farms per kilometer (judged to be the minimum number of farms that would ensure a favorable benefit/cost ratio), (4) served a zone of influence which had a significant agricultural potential, and (5) served an area with a strong indication of community interest in providing labor for the road construction.

The economic feasibility was verified by calculating the benefit/cost ratio for each road and by developing a detailed estimate of community interest in providing labor for the construction of the road. Those roads with a favorable benefit/cost ratio and good indication of community interest were then subjected to the final ranking phase.

The final phase of ranking in terms of priority was proposed to be done on the basis of the weighted sum of four key variables: economic feasibility (benefit/cost ratio), number of farmers per kilometer, current average farm family income, and average hectares under cultivation per farm. From one to four points were to be assigned to each of these variables depending on their value. For example, if the average farm family income fell between $200 and $300, it was assigned three points. The sum of the points for a road established its priority rank.

The proposed selection procedures for Rural Roads I proved too complex for practical use in Bolivia at the time of implementation of the road program.[3] There were several crucial difficulties with the procedures for the first rural roads project of which the most important were (1) the development of the weighted rank scale and socioeconomic data collection necessary for the ranking of the roads, and (2) the calculation of the benefit/cost ratio. Apparently, the use of present value

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[3]See Road Selection Criteria and an Evaluation Plan for the Bolivia Rural Roads II Project, Practical Concepts Incorporated (PCI), undated but believed to have been published around April 1980.

tables presented difficulties to the implementing agency which was still in its infancy at that time.

After the complexity of the Rural Roads I selection procedures were identified as an implementation problem, AID and the implementing agency developed revised procedures that simplified the selection process. The calculation of the benefit/cost ratio was made easier by the use of a nomogram (a graphic representation that facilitates the determination of unknown values by using known values as reference points), and a questionnaire was developed to facilitate the collection of socio-economic data on each road. Apparently, and the consultant's report does not give much detail here, the revised procedures were based mostly on the benefit/cost ratio which was used as the primary test for selection of the roads.

Under Rural Roads II, now in abeyance because of the recent revolution, a substantially revised four-stage selection process is to be used. Testing of these new procedures must await resumption of the program.

D. Kenya Rural Roads System Project (AID, IBRD, and Other Donors, Ongoing)

The roads in this project are local rural roads of low design standards and are being constructed using labor-intensive techniques. Identification of the roads is done at the local level, and selection and evaluation are done by the central Government. The District Development Committee (a local government organization including both government officials and a few nominated private citizens and nonofficial members, and assisted by units at the local level) identifies and compiles a list of 600 to 900 kilometers of local rural roads in the district for improvement (including both reconstruction and upgrading). The broad criteria used in this identification are provided by the centrally located Ministry of Transport and Communications (MOTC) in Nairobi.

After receiving the list of candidate roads, the planning unit of the MOTC begins the appraisal by calculating an "accessibility index" for each road. This index is structured to be proportional to (1) the population in the road's impact area; (2) the weighted distance this population has to travel to reach health services, a post office, and Divisional Headquarters; and (3) the frequency with which these trips are undertaken. For example, trips to hospitals are considered to be of low frequency and therefore receive a low weight, whereas trips to the administrative center are considered to occur with a high frequency and receive a high weight. The roads are then ranked in order of the size of their accessibility index. This results in high ranks for roads that are believed to have the highest potential travel demand. Using conventional techniques, the internal rate of return is then calculated for the whole set of ranked roads, which is then submitted to AID for review.

The approach used in Kenya has several weaknesses. Perhaps the most important weakness is that the internal rate of return is calculated for the whole set of roads, and not for individual roads. Thus, even though the set may contain economically nonproductive roads, these roads are included since they ride on the coattails, so to speak, of the economically feasible roads.[4]

In theory, all roads submitted by local government are included in road development proposals to which these processes are applied. In practice, however, both the Kenyan planning unit and AID apply informal procedures to eliminate those roads that, in their judgment, do not appear promising. The Kenyan Government realizes these weaknesses and, assisted by the other donors involved in the project (mainly the World Bank), is attempting to improve the selection procedures. A recent directive by the World Bank requires that the internal rate of return must be calculated for each road and must be used as a pass/fail criterion.

E. Philippines (AID, Ongoing)

A three-phase process is used for selecting the local rural roads under the Rural Roads II project: screening, appraisal, and ranking.

Screening is a preliminary procedure performed at the local level by the Provincial Development Staff (located in the office of the Provincial Engineer and under the Governor's office) to eliminate those roads proposed by lower government levels that do not satisfy certain basic criteria. These criteria were developed jointly by AID and local government. Conditions for eligibility include the following: (1) the road must not serve special interest groups such as plantation owners or logging firms, (2) the road must link with a road of equal or higher quality, (3) the road must be part of a connected system that provides access to markets or administrative centers, (4) the right of way must be titled, and (5) the road must run through areas dominated by small farmers. All five criteria must be satisfied to "pass" a road.

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[4]See the AID Kenya Rural Roads, Impact Evaluation Report No. 26, for further details.

Roads that survive the screening process are then subjected by the Provincial Development Staff to a second phase consisting of detailed economic assessment to calculate the internal rate of return or benefit/cost ratio. This method uses the elaborate procedures based on the "producer surplus" concept outlined in the Word Bank Working Paper No. 241. Only those roads that have a benefit/cost ratio larger than 1.0 or an internal rate of return larger than 15 percent are admitted to a third phase, the final ranking process.

The purpose of the third phase is to determine the construction priority of each road. The ranking consists of a modification of the weighted rating techniques described earlier. Typical factors of the road's potential effects to which weights are applied include the agricultural production in the road's zone of influence, average farm size, availability of complementary services, traffic volume, transport and project cost, employment generation, population, and access to social services. Though commendable in principle--except as noted in the paragraph below--this procedure needs testing and modification since there is considerable overlap and double counting among the factors, and methods must be found to make the weights less arbitrary. AID is providing technical assistance to the Philippines local government to improve the selection procedures.

It should be noted, however, that performing the costly and time-consuming benefit/cost analysis on all the roads during the appraisal phase may waste considerable effort since several of these roads may be eliminated during the subsequent ranking phase. For the selection procedures suggested in this report, this waste is avoided since the economic justification is done in the ranking phase only for those roads that have passed through the first two phases of this process.

F. Dominican Republic Rural Roads Maintenance and Rehabilitation (AID, Ongoing)

The selection of roads is carried out by the Feeder Roads Unit of the Ministry of Transportation, assisted by a consultant who prepared a manual entitled Manual de Evaluacion Socio-Economica de Caminos Vecinales. This manual was published by the Direccion General de Caminos Vecinales (DGCV) under the jurisdiction of the Secretaria de Estado de Obras Publicas y Communicaciones, and was released early in 1982. The procedure is based on the calculation of a comprehensive feasibility index of the socioeconomic feasibility for each road in the project. This feasibility index is defined as the ratio between the road's socioeconomic benefits and its improvement cost. The socioeconomic benefits for each road are calculated as the weighted score of 11 factors consisting of population density, access to markets, road condition before improvement, degree of community organization, farm size distribution, land use potential, school enrollment, health services, potential for erosion, presence of development projects, and the importance of agriculture in the road influence area (RIA). Each of these factors is scaled into three levels. The three levels for population density, for example, are "low," "medium," and "high." Each of these levels is assigned a weight expressed in "points." Again, for example, for population density, a road gets only 20 points if the population density in the road influence area is low, 40 points if it is medium, and 60 points if it is high. The development of the weights is a joint effort of AID and the DGCV.

The index for the socioeconomic benefits is the sum of the points for the 11 factors, and the score for a road will fall between a minimum of 105 and a maximum of 360 points.

The denominator of the road feasibility index is taken as the approximate cost of the road improvement and future maintenance. The criterion for ranking or prioritizing the roads is defined as the ratio between the point value of the socioeconomic benefits and the dollar cost of road improvement. The higher the number of socioeconomic points per dollar improvement cost, the higher the ranking of the road.

After the ranking is finished, roads are selected for improvement in order of their rank until the project budget is exhausted. Allowance is made during the selection of the roads to ensure that interdependencies between the links are taken into account, and that certain special conditions are considered.

The selection does not include any quantified considerations of the economic value of the road and none of the standard measures such as the benefit/cost ratio, net present value, or internal rate of return is calculated. Rather, the focus appears to be on the road's social impact. Although several of the indicators of a road's economic feasibility, such as the potential of the farmland in the RIA, are included in the index of socioeconomic feasibility, experience has shown that this does not ensure that highly ranked roads are economically feasible. The selection procedures would be improved if an economic feasibility test were applied after the socioeconomic ranking.

G. Colombia Rural Roads Project (IBRD, Ongoing)

The selection procedures used in this project are third generation in that they evolved from two earlier projects, the AID-sponsored labor intensive Pico y Pala Project, and the follow-on Inter-American Development Bank Rural Roads Project. The same Colombian agency, the Fondo Naccional de Caminos Vecinales (FNCV), was involved in refining the criteria through these three evolutions, and the procedures therefore reflect a relatively high level of continuity and consistency.

The selection methodology is applied in two phases. The main objective of the first phase is to eliminate those roads that have little probability of being economically feasible, and also to develop a priority ranking of the road projects. Each of the roads proposed by the local communities is evaluated using information about the terrain, population density, land distribution, potential for increased agricultural production, distance to markets, and availability of complementary services. This information is obtained by a specially trained field engineer from the FNCV, who assigns "points" representing benefits or costs for each of these factors. The engineer looks up the point value from a manual prepared by the FNCV. An example showing a small portion of this table is presented in Table 1 below.

Table 1. Sample of Road Selection Factor Point Values From FNCA Manual

Factor	Measure	Point Value
Location of Borrow	Further Than 15 km Away	16
	Between 5 and 15 km Away	11
	Less Than 5 km Away	6
Percentage of Land Tenancy on Small Farms	Between 0 and 10 Percent	10
	Between 10 and 20 Percent	5
	Larger Than 20 Percent	0
Percentage of Land Tenancy on Large Farms	Between 0 and 10 Percent	10
	Between 10 and 20 Percent	5
	Larger Than 20 Percent	0

After adding up benefit-related points and cost-related points, a proxy for the benefit/cost ratio is calculated. This proxy is used to rank the roads in descending order for further evaluation during the second phase until the total available road budget plus 20 percent is covered. The 20 percent margin is intended to ensure enough roads for construction should any of the preselected roads not pass the second phase.

During the second phase, the economic rate of return for each road is calculated using traditional methods. Those roads with an internal rate of return lower than 11 percent, the estimated opportunity cost of capital, are rejected. Then, using approximate but adequate procedures, the social rate of return (see below) is calculated and is used to establish revised priorities among those roads that have passed the internal rate of return test.

The social rate of return reflects the Government's objective to assign preference to gains that will accure to the poor, and is calculated by applying income distribution weights to the flow of benefits from the projects according to a simplified version of the standard social accounting approach described in Squire and van der Tak.[5] The effect is to raise the rank of those projects that favor the poor.

The FNCV believes that, with correctly chosen weights, there should be a good correlation between the surrogate benefit/ cost ratio calculated in the first screening phase and the traditional and social internal rate of return calculated in the second phase. If true, the selection procedures could be greatly simplified since the first phase yielding the surrogate benefit/ cost ratio then would be sufficient to establish priorities and to identify a cut-off point for the implementation of the projects. However, the reliability of the surrogate benefit/cost ratio has not yet been verified, and experience with attempts to develop surrogates for the benefit/ cost ratio on other projects indicates that reliability may be difficult to achieve.

H. Applying Linear Programming Techniques to Road Selection Procedures

In a recent paper published at the Second International Conference of Low-Volume Roads, researchers at the Massachusetts Institute of Technology proposed that linear programming

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[5]Lyn Squire and Herman G. Van der Tak, Economic Analysis of Projects, Johns Hopkins University Press, 1975.

be applied as a tool to assist in the formulation of the factor weights used in the priority ranking of roads.[6] To illustrate, assume that for a particular project the following four factors will be used: economic feasibility, income distribution, generation of employment, and accessibility to social services. Given that we can estimate the contribution that each of these four factors will make toward the project objectives (for example, on a scale going from zero to 100 the factors for a particular road may score 66, 73. 25, and 82, respectively), weights must be established to represent the importance of each factor. (More detail on scaling and weighting of factors is given in Section IV.)

In past practice these weights were either equal for each factor (an unsatisfactory procedure), or cardinal weights had to be estimated. In the above example these cardinal weights might be 0.45, 0.36, 0.10, and 0.09 respectively. Consensus by the parties involved in developing these weights has not always been easy to attain. As an alternative, therefore, MIT proposes to use linear programming as a tool in formulating appropriate weights. The only requirement to make this apporach feasible is that it be possible for each person to rank the factors in order of their importance (ordinal ranking). Such ranking is usually as easier task for the parties involved than is reaching a consensus on cardinal weights. For example, the ordinal ranking by a particular judge might reveal his preference that the factor of economic feasibility is of highest importance, followed by accessibility to social services, then income distribution, and finally employment generation. The ranking, of course, will in general be different depending on the particular judge. The MIT research shows how, using only ordinal rankings, a linear programming model can be formulated and solved to yield cardinal weights that satisfy certain interesting properties and that are consistent with the ordinal rankings.

The approach recommended by MIT is intriguing. However, it remains to be tested in the field.

III. DESIRABLE FEATURES OF SELECTION CRITERIA

This section discusses the features deemed to be desirable in selection procedures. These procedures should have the following characteristics: (1) they must be comprehensive and

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[6]Janet A. Koch, Fred Moavenzadeh, and Keat Soon Chew, "A Methodology for Evaluation of Rural Roads in the Context of Development," Transportation Research Record 702, August 20-23, 1979.

must give consideration to economic growth, quality of life, and equity; (2) the cost of applying the procedures must be commensurate with their reliability in selecting feasible roads, i.e., the procedures must be efficient; (3) they must be applicable by locally trained professionals under field conditions; and (4) they must have the flexibility to allow application of "best judgment" by experts, but with explicit and verifiable assumptions. We will discuss each of these features in more detail below.

A. Comprehensiveness of Procedures

The procedures must be capable of taking into account a broad range of rural development objectives and of considering both the economic and noneconomic components of the objectives. An improvement in health, for example, has both an economic component--healthy farmers probably work harder in their fields and till more acreage than unhealthy farmers, thereby contributing to higher agricultural productivity--and a noneconomic component--healthy farmers simply feel better. As another example, an important objective of many AID road projects is to improve access by the rural population to educational facilities. Improvement in education also has an important economic component: better educated and literate farmers probably work more productively and are more responsive to new techniques than illiterate farmers. The noneconomic component of a better educated rural population would be that they lead a life that is more interesting and richer by enabling them to fulfill their inherent potential.

In the past, the economic components of factors such as better health and education that are facilitated by better access have traditionally been included in project justification although the underlying assumptions were almost never made explicit. For example, a typical procedure used in projecting the increases in yields that could be expected in the road influence area (RIA) after the road improvement was to study crop yields in a nearby reference area where, because of good roads, access to markets and agricultural services had been satisfactory for some time. Provided that the reference area also had soil fertility similar to that found in the RIA of the project road, and that many other factors of the population, such as climate and cultural characteristics, were also reasonably comparable, the yields along the project road could be projected to be very similar to those of the reference road. For example, if the historic annual yield of corn in the RIA of the project road was 2.4 tons per hectare, whereas the yield in the reference area was 2.8 tons per hectare, it could reasonably be assumed that, after the improvement of the project road, yields in the RIA would increase from 2.4 tons to

2.8 tons per hectare. This increase in yield, in addition to capturing the increase due to the stimulus provided by the higher farmgate price, lower prices of inputs, and improved services, also captures the higher farmer productivity due to improved health and education.

To be comprehensive, however, the procedures must also include the noneconomic component of factors such as improved health and others that relate to better quality of life rather than higher productivity. This noneconomic component cannot be quantified in the same monetary units in which the economic factors are measured. Thus, the condition that the selection criteria be comprehensive (in that they take into consideration the full spectrum of development objectives that the rural roads project attempts to meet) requires that we depart from the traditional single-objective analysis technique that stresses only measurement in monetary terms, such as producer and consumer surplus, savings in road user costs, and travel time savings. Multiple-objective analysis, recommended in this paper, can take into account both economic and noneconomic objectives in a single evaluation framework. Thus, it meets the criterion of being comprehensive. The technique is not new, and has been used in such diverse fields as engineering, psychology, management, and project evaluation.[7]

B. Efficiency of the Procedures and Level of Effort

It is apparent from this review of the selection procedures used in the past that the reliability of the procedures often left something to be desired. In some cases the level of effort that went into the selection was insufficient to really identify and separate the road projects that should have been undertaken from those that should not. As a result, roads were constructed that should not have been constructed, and roads that should have been constructed were mistakenly identified as infeasible. Both types of mistake are costly in terms of project benefits foregone.

The concept of the reliability of a selection process is illustrated in Table 2 below. The data apply to a rural roads project consisting of 100 roads, where 70 roads are known to be feasible and 30 roads infeasible. These feasibility levels would be established by applying "perfect" selection procedures including comprehensive economic and social assessments and

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[7]A good review can be found in Koch, Moavenzadeh, and Soon Chew, *op. cit.*

extensive collection of data. But to test the imperfect selection procedures, the classification of the roads, as shown in the table, differs. In this case only 60 of the roads known to be feasible are classified as feasible, and only 5 of the roads known to be infeasible are identified as infeasible. The selection procedures for identifying "good" roads as good have a reliability of 60/70 = 86 percent. Their reliability in identifying "bad" roads as bad is only 5/30 = 17 percent. The overall reliability of the selection procedures is (60 + 5)/100 = 65 percent.

Table 2. Illustration of the Concept of Reliability of a Road Selection Process

	Actual Case[1]	Predicted by Selection Procedures: Feasible	Predicted by Selection Procedures: Infeasible	Reliability
Number of Roads Called Feasible	70	60	10	86%
Number of Roads Called Infeasible	30	25	5	17%
Total	100		Overall	65%

[1]As determined by "perfect" selection procedures.

There may also have been cases where the level of effort that went into the selection procedures was too high. In such cases a reduction in the effort devoted to selection would have resulted in only a negligible loss of reliability. In other words, the analysts were operating on the part of the curve with diminishing returns. Such a practice also wastes money since the total benefits of a road project are reduced by the cost of any excess analysis. Unfortunately, very little is known about the tradeoff between "too much" and "too little" analysis. Compared with the total benefits produced by a road project, however, the cost of excess analysis (provided it is competent analysis, of course) is probably negligible. In all likelihood, it is probably better to err on the side of too much analysis than it is to do the converse.

In summary, the cost of a road selection procedure comprises the following components: the cost of field data collection, the cost of processing and analyzing these data, and the cost of foregone benefits due to the lack of precision of the road selection process. In general, if the data collection and analyses costs are kept too low, the cost of imprecision is likely to be high, and conversely. We can define an "efficient" selection process as one where the costs of data collection, processing, and analysis are balanced with the cost of precision. Ideally, the optimum effort in road selection would occur where an additional dollar spent on, say, additional data collection would be offset by an additional dollar of benefits gained.

The final section of this report will discuss what are judged to be appropriate levels of effort for the road selection process.

C. Ease of Application of the Selection Procedures

Road selection procedures must be capable of being applied by host government personnel with leadership provided by the AID mission direct-hire personnel or by a consultant. The impact evaluations found that road projects in which the host government, including both central and local governments, had participated in the selection of the roads had a higher chance of being successful than those projects that were selected exclusively by expatriates. This requirement rules out selection procedures that depend on assistance from large computers. Microprocessors are in order, however, and procedures that depend on programmable calculators are also quite appropriate.

IV. PROPOSED SELECTION PROCEDURES FOR RURAL ROADS PROJECTS

A three-phase selection procedure consisting of screening followed by socioeconomic ranking and economic appraisal is recommended. This will ensure that the selected roads are both economically feasible and have a high social impact. The approach is based on several important assumptions that will be mentioned in the description of each phase. The first or screening phase is required because several of the roads initially proposed for a project probably cannot be justified because they do not contribute to one or more of the basic AID rural development objectives. Second, though the need to establish the economic rate of return is recognized, it is also true that the economic return of a project by itself accounts for only part of the value of the investment. For this reason, a second phase is proposed that focuses on social aspects and ranks the roads in order of their socioeconomic impact. Third, a requirement to establish a quantified economic return measured by an index such as internal rate of return is proposed, though it is recognized that the economic return can be only an approximation of the true economic value of the project because of frequently encountered weaknesses in the data bases available and the many uncertainties associated with important parameters of projects. Thus, the third phase consists of verifying the economic feasibility of those roads that receive a sufficiently high grade in the preceding phase of socioeconomic ranking. This second phase cut-off grade is determined by the size of the road improvement budget, and should be low enough so that included roads absorb all of the budget plus a 20 percent margin to allow for the possible elimination of road projects that fail to pass the subsequent third phase economic feasibility test.

A. Phase I: Initial Screening

Screening is not a superficial operation that can be done behind a desk. Each road will require a physical inspection by a small team of experienced technicians[8] to obtain the minimum required information on the following factors:

1. Exact location and length of proposed road and nearby roads possibly serving the same road influence area (RIA)

2. Size and nature of population served

3. Attitude of local communities toward the road project and their commitment to maintenance

4. Characteristics of land ownership and the distribution of income in the RIA

5. Present condition and proposed improvement of the road and a rough estimate of the improvement cost (within 30 percent)

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[8]The team members can be drawn from local personnel but should be closely supervised by USAID. The team should preferably consist of two members: one with an engineering background and the other with a social science background. In cases where a single person is expert in both disciplines, the team could, of course, be reduced to one member.

The following list presents the screening criteria proposed for a recent project in Haiti, and is provided here for illustrative purposes. Their applicability is quite universal, however, and should provide a good point of departure for other projects. The candidate road projects must satisfy all of these criteria to be eligible for the second phase, that of socioeconomic ranking.

1. The road must be part of a network leading to a local or regional market and administrative center, and must connect with an existing all-weather road or an improved port leading to a regional market and administrative center.

2. The road project should be endorsed by local communities and community groups.

3. The road must not be closely parallel to or in the RIA of another all-weather road or road scheduled for construction to all-weather standards.

4. Except for penetration-type road projects, the population density in the RIA must be at least 50 persons per kilometer of road (road improvement projects are seldom economically justified in areas with a population density in the RIA of less than 50 persons per kilometer of road[9]).

5. The road must not lead primarily through plantation areas (such as sugarcane plantations) or any area where it is known that the majority of the land is held by large landowners.

6. The road shall not contribute to erosion, adversely affect drainage, or interfere with irrigation of farmland along the road.

7. The road can be rehabilitated/constructed primarily through labor-intensive methods.

This set of criteria for preliminary screening of candidate roads reflects current AID policy regarding the distribution of benefits while stressing the need to verify acceptable economic rates of return for projects financed by AID. It also

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[9]The 50-person cut-off level is only an estimate based on limited experience in several countries. Research is urgently needed to obtain quantified screening criteria based on population, level of farm technology, and other attributes of the RIA.

recognizes that the project's economic rate of return--in addition to being only an approximation of the real economic value of the project due to measurement uncertainties and imperfect analytic techniques--does not fully reflect the total value of the investment because noneconomic factors are not included. Phase II (discussed below) aims at including both the economic return criteria, through use of indices of the project's economic feasibility, and the value of the noneconomic social factors.

B. <u>Phase II: Socioeconomic Ranking</u>

The procedures for socioeconomic ranking must be comprehensive in that they must consider both the <u>economic</u> and <u>noneconomic</u> components of the objectives. An improvement in health, for example, has both an economic benefit--healthy farmers work harder in their fields and till more acreage than unhealthy farmers, thereby contributing to higher agricultural productivity--and a noneconomic benefit--healthy farmers simply feel better.

The economic component of a factor such as better health is, for the most part, implicity included in the projections of economic growth that are expected from the road improvement project. For example, as was mentioned earlier in this report, a typical procedure used by a transport economist in projecting the new yields to be expected in the RIA after the road improvement is to study yields in a nearby reference area where, because of good roads, access has been satisfactory for some time. Provided that the reference area also has soil conditions similar to those found in the RIA of the project road, that other factors such as climate and cultural characteristics are reasonably comparable, and that after project completion the health services along the project road will be similar to those of the reference area, the future yields along the project road can be assumed to be similar to those of roads in the reference area.

To be comprehensive, however, the selection and justification procedures must also consider the noneconomic factors. We are therefore faced with the problem of having to deal with multiple objectives, and these objectives are, to a degree, in conflict with each other. Choosing roads based on maximizing the economic impact will result in a different selection than if the choice were based on maximizing, say, access to health facilities. Fortunately, there are techniques for analyzing a problem in the context of multiple objectives. The major problems in applying these techniques in dealing with multiple objectives are (1) assessing the relative importance of the multiple objectives, (2) measuring the outcomes of each project in terms of these objectives, (3) obtaining a common measure for the multiple objectives having different measures, and (4) combining all these into a single indicator of the merit of each road project.

The Rural Roads and Transportation Working Group (RRTWG) has classified the economic and noneconomic objectives into three major categories of road impact: economic activity, quality of life, and equity. Other categories may also be included although more than four categories would complicate the estimation of the factor weights discussed below. (For the Haiti project, for example, the category of "regionalization," reflecting AID's regional priorities, was included as a fourth category.)

Measurement of the contribution of each of these categories to the overall objective of the road improvement program is facilitated by disaggregating each category into several major factors as discussed below.

1. Economic Activity

Economic activity is disaggregated into three factors: (1) an indicator of agricultural potential,[10] (2) the degree of access improvement, and (3) the existence of parallel development activities in the RIA. Given that we can scale the contribution that each of these three factors makes towards the project objectives (for example, on a scale going from zero to 100 the factors for a particular road may score 65, 40, and 53, respectively), weights must be established to represent the importance of each factor. In Table 3 (using the Haiti project example) these weights are taken as identical at 10 percent for each of the three factors.

In developing these weights, it is preferable to include, where practical, decision-makers who are involved in rural development at both the local and central government levels, and, ideally, community leaders. Consensus in determining these weights can be achieved either by asking each participant to rank the factors in order of importance and then normalizing the various rankings, or by asking each participant to assign subjective weights to each factor and then averaging the

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[10]This is only an indicator, and may consist of no more than a subjective estimate by an experienced agronomist of the basic agricultural potential of the RIA as dependent on resource factors such as soil quality, weather and rainfall, elevation, terrain, and cultural factors.

Table 3. Selection Criteria for Haiti Secondary Roads Project: Phase II--Socioeconomic Ranking

General Category and Overall Weight	Factor	Unit	Quantity	Scale
A. Economic Activity (30)	Agricultural potential indicator	Qualitative assessment of agricultural potential	Good Fair Poor	100 60 30
	Degree of access improvement	Road condition before improvement	No road (Category 3) Poor road (Category 2) Fair road (Category 1)	100 60 20
	Complementary services and planned development activities in the RIA[1]	Dollar cost of planned complementary activities per km of road	000	0-100
B. Quality of Life (30)	Population served	Population in the RIA per km of road	0-2000	0-100
	Access to social services	Improved from no access to any services to access to both primary and secondary services (Level A improvement)	Good improvement	100
		Improved from no access to any services to access to secondary services only (Level B improvement)	Fair improvement	66
		Improved from access to secondary services to access to primary services	Poor improvement	33
		No improvement	No improvement	0
C. Equity (30)	Existing income distribution	Farmland distribution	Small farmers own less than 20% of land	0
			Small farmers own from 20% to 60% of land	50
			Small farmers own more than 60% of land	100
	Distribution of incremental income	Fraction of transport cost savings passed on to users	More then 80% (highly competitive)	100
			Between 40% and 80% (competitive)	50
			Less than 40% (noncompetitive)	0
D. Regionalization (10)	Regional priority	Conformance with Country Development Strategy Statement Food Sector Strategy	Southwest Northwest Other regions	10 7 0

[1]RIA = Road Influence Area.

weights. Overall weights assigned by the participants will then be averaged as well to arrive at the consensus. Table 4 presents an example of the final weights that might be assigned by each of the participants. Actual consensus on these weights should be achieved soon after project implementation.

2. Quality of Life

This is the second major objective category established by the RRTWG. It pertains mostly to access to social services. Road improvement may affect the accessibility to social services both through an improved level of transport services (from walking to riding, for example, or from high-cost unreliable service to cheap and reliable service) to existing hospital and other services, and by enabling the construction of additional health posts and other service facilities that may follow the road improvement.

One might first define the various levels of social services available, and then define the degree of improvement in access to these social services. In the Haiti project, for example, two levels consisting of primary and secondary social services were defined for both health and education; each level had four sublevels:

Primary Services

Education	Health
1. Primary Schools	1. Visiting Trained Nurse
2. Secondary Schools	2. Visiting Health Clinic
3.	3. ......
4.	4. ......

Secondary Services

Education	Health
1. Vocational School	1. Permanent Health Clinic
2. Adult Education	2. Visiting Doctor and Nurse
3.	3. ......
4.	4. ......

Table 4. Weights Assigned to Socioeconomic Factors by Participants in the Haiti Secondary Roads Selection Process (illustrative)

Factor	Weights Assigned by Participant[1] 1	2	...	N	Average
Economic Activity	30	25	...	40	30
Agricultural Potential	10	5	...	10	10
Degree of Access Improvement	10	5	...	10	10
Complementary Services and Planned Development Activities	10	15	...	20	10
Quality of Life	35	30	...	45	30
Population Served	15	10	...	20	10
Access to Social Services	20	20	...	25	20
Equity	30	35	...	15	30
Existing Income Distribution	10	20	...	5	10
Incremental Income Distribution	20	15	...	10	20
Regionalization[2]	5	10	...	0	10
Total	100	100		100	100

[1]Participant No. 1 - TPTC Advisor/Economist
Participant No. 2 - TPTC Engineer
Participant No. 3 - USAID Rural Development
Participant No. 4 - USAID Engineering
Participant No. •
Participant No. •
Participant No. •
Participant No. •
Participant No. N - Community Council Leader, Southwest Region

[2]Policy criterion.

The project defined four degrees of access improvement to social services:

1. No Improvement - This occurs when a village perceives no change in service facilities or services available after the road has been constructed or improved.

2. Poor Improvement - This occurs when access to <u>only</u> secondary or <u>only</u> primary services is improved to include access to <u>both</u> secondary and primary services.

3. Fair Improvement - This describes the improvement from no access to any services to access to only secondary or only primary services.

4. Good Improvement - This describes the improvement from no access to any services to access to both primary and secondary services.

These measures entail a subjective estimate of "access" which is best made by an expert in the provision of health, educational, and other social services. The concept of access is somewhat complicated because in this context it must involve both "physical" accessibility (referring to the cost and time required to reach the facility) and the access to services once one has arrived there. The following example may clarify the concept. Consider a health center that is chronically out of medicines, has poorly trained staff, and is connected to a village three kilometers away along an all-weather road. The physical access to the facility is satisfactory, but the access to services is poor. In sum, we could not say that the villagers had adequate access to health care.

As another example, take the situation where a village is visited once a week by a doctor who arrives over a poor road on muleback, and where the doctor finds several hundred patients waiting for treatment. Again, one cannot say the villagers currently have "good access" to medical services, and the expert will have to judge whether or not the access to medical services will be improved after the construction of the road. This may well occur since the visiting doctor can now make the trip by car, and he will have more time to treat patients. He may also decide to increase the frequency of his trips or to take along a nurse. Finally, the villagers may now be able to take public transportation to another health center, thereby reducing the visiting doctor's workload.

Table 5 illustrates a systematic way of obtaining an overall weighted value for the access improvement of a village located in the RIA of a proposed road project. It should be stressed again that access is obtained only if both physical access (sometimes referred to as "mobility") and access to services are improved.

3. Equity

Equity is measured in terms of existing income distribution and the expected distribution of the incremental income resulting from the road improvement project (combined with complementary development activities, if any). This measure is related to the distribution of project benefits among the project beneficiaries, and therefore to the expected degree of alleviation of poverty among the poorest element of the population in the RIA. Since income data are almost impossible to obtain in many countries, proxy measures must be used. The distribution of ownership of cultivable land can serve as a proxy for the existing income distribution, and the share of transport cost-savings passed on by the vehicle operators to the road users (both passengers and shippers of agricultural products) as an estimate of the distribution of incremental income. Estimates of the existing farmland distribution in the RIA were categorized at three levels for Haiti, as follows:

Level 1. Small farmers/landholders (those with less than 4 hectares) own less than 20 percent of the land in the RIA.

Level 2. Small farmers/landholders own between 20 percent and 60 percent of the land in the RIA.

Level 3. Small farmers/landholders own more than 60 percent of the land in the RIA.

The distribution of incremental income, expressed in terms of the fraction of transport cost savings passed on to the users, can be estimated by the degree of competitiveness of the transport industry expected after the road improvement has been completed. Such an estimate of the expected degree of competitiveness of the trucking industry can be obtained by interviewing farmers located along a road that is similar to the improved project road.[11]

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[11] See Rural Roads Evaluation Summary Report, AID Program Evaluation Report No. 5, March 1982, pp. E21-E25.

Table 5. Method for Obtaining Weighted Value of Improvement in Access to Services of a Village After Road Improvement

Access to Secondary Services		Access to Primary Services					
Without-Project	With-Project	Without-Project	With-Project	Level of Access Improvement	Points on Scale (from Table 3)	Weight, % (from Table 3)	Weighted Value
No	Yes	No	Yes	Good (1)	100	20	20.0
No	Yes	Yes	Yes	Poor (3)	33	20	6.6
No	Yes	No	No	Fair (2)	66	20	13.2
No	No	No	No	None (4)	0	20	0.0
No	No	No	Yes	Fair (2)	66	20	13.2
No	No	Yes	Yes	None (4)	0	20	0.0
Yes	Yes	Yes	Yes	None (4)	0	20	0.0
						Total Weighted Value	53.0

C. Phase III: Economic Justification

The economic appraisal of each road must be based on an assessment of its likely developmental impact on agricultural production and improvement in personal mobility rather than solely on benefits arising from reduction in transport costs for existing and projected traffic. Farm-to-market roads can be analyzed on a one-by-one basis. For secondary road improvement projects, however, consideration must be given to the interrelationships among the road links, and the analysis may have to be done in the context of subnetworks.

For example, the economic justification of the improvement of a specific secondary road must take into consideration the status of the network connecting this road with the rest of the country to verify that the connecting roads provide adequate access. There also may exist important diversions of traffic to the improved road from other roads or transport modes such as links in the coastal waterway system that must be taken into account.

Ideally, network analysis should be done using a model that considers the interrelationships among all links. Such a model can be complex because of the potentially large number of possible interrelationships between the links of even a small system, and computerization is usually essential. Fortunately, the network of a rural roads system is usually a simple one in that only a few roads are strongly interrelated, and the network can usually be divided in subnetworks which are independent and which can be studied in isolation. These subnetworks can be identified easily by persons with knowledge of the transport flows and the major markets for farm produce.

It should be noted that if the road improvement cost is held as low as possible, the cost of possible errors introduced by the simplified network analysis is not great. If more traffic than expected materializes on one of the improved roads, that road can later be updated to design standards appropriate to the higher traffic level. Because the additional investment has been postponed for several years, the discounted value of this additional cost effectively reduces the cost of the road upgrading. In fact, this procedure is similar to the staging approach (build simply at first and upgrade later if necessary) used for those transport projects where traffic demand projections are uncertain.

For purposes of economic evaluation, roads (or road sections) will be grouped into three broad categories defined in terms of existing access conditions. The categories of roads, the type of needed improvements, and the nature of economic benefits associated with such improvements are as follows:

Category 1. This category includes roads that are in fair condition and serve the existing agricultural activities within the area reasonably well. Benefits from induced agricultural production and generated traffic are not likely to be significant since these roads, even in their present state, provide adequate access between farm areas and the main road network. Estimates of normal traffic and vehicle operating costs, the major benefits, will be used for calculating road user cost and time savings.

Category 2. This category includes roads that are mostly in poor to fair condition and with poor drainage. This means that there is only partial access to the area, and some induced agricultural production and generated passenger traffic can be expected to result from the improvement of the roads. There is existing motor vehicle traffic, but road user costs are generally high. In addition to the expected benefits from induced agricultural production, road user cost savings will also accrue to normal and generated traffic. To avoid double counting, generated traffic benefits from induced agricultural production will not be included in the estimates of road user benefits.

Category 3. This category includes construction of new roads and/or improvement of existing tracks requiring considerable reconstruction. These roads have little or no motor vehicle traffic; a major portion of the existing traffic consists of pack animals or pedestrians. These roads provide very poor accessibility to the area which they serve. The induced agricultural production and generated traffic might be significant with the improvement of these roads, especially if complementary services such as agricultural extension and credit are made available. The benefits for roads in this category are calculated the same way as for Category 2 roads.

1. Estimates of Population, Agricultural Production, and Agricultural Marketable Surplus

For the rural areas in which many of the candidate links are located, data on population and agricultural productivity are often not available in the capital city and must be collected in the field. Field interviews with farmers, the area agronomist, local extension workers, and other knowledgeable individuals must be conducted to collect such data as the population served, the total number of farmers, the average farm size for each road, yields and production costs, and per capita consumption of farm products on the farm.

It is realized that these interview techniques provide only approximate information and that the production forecasts might contain quite substantial errors unless techniques such as sensitivity analysis are used to identify particularly sensitive variables. The two most sensitive variables affecting increases in agricultural production, quite naturally, are the projected increase in cultivated area and the projected increase in yield. Care must therefore be taken to assume conservative values for these variables to avoid inflated projections of increases in agricultural productivity.

2. Economic Justification Methodology

There are a number of approaches to establishing the economic rate of return for individual roads. These approaches all use the well-established principles of economic benefit/cost analysis described in many text books.[12] The procedures differ, however, in level of effort devoted to the analysis. Where the personnel resources are available, the ambitious methods outlined in World Bank Working Papers No. 241 and No. 362 may be applied. Where resources for analysis are more scarce, simplified versions may be applied, such as those planned for the Haiti project (see below).

The application of the economic methodology is best illustrated by following the calculations made for the economic justification of a road link taken from the Haiti Secondary Rural Roads Project. A simplified application of World Bank Working Paper No. 362 is made. The road link (link no. 143) is located in the Southwest and leads from Carrefour Zaboca to Carrefour Charles and Roseaux. It is about 28 km long, links the important towns of Jeremie and Les Cayes, and consists of a gravel-surfaced road with an average width of four meters. The road is Category 2 (fair-to-bad condition). Average annual traffic is estimated at between 15 and 20 vehicles per day, mostly trucks, with an average travel speed of 22 kilometers per hour.

It leads through mountainous terrain, and the farmers in the road influence area grow maize, coffee, tubers, plantain, and beans. The largest town on the link is Beaumount, with a population of about 1,100 people; 24 small villages, with a total population of about 4,000 people, are located along or near the road. The total population in the RIA is about 50,000 as estimated from a census count made in 1979 by Catholic Relief Services and from estimates provided by the district agronomist of the number of farm families. Total cultivated area, again estimated from the number of farm families and the average area per farm (about four hectares per farm) is about

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[12]See for example, S. Glaister, Fundamentals of Transport Economics, New York: St. Martins Press, 1981.

33,000 hectares. Extension services are minimal, although there is a growing agricultural credit program, and therefore it is assumed that the road improvement would not induce any short-term increase in yield. In the short-to-medium term, however, better transport would reduce crop spoilage, both during transport and while waiting for transport, by 5 percent, and would also lower the cost of transport. To facilitate the computation of the economic rate of return, the 5 percent reduction in spoilage is assumed to be equivalent to a 5 percent increase in yield. A major assumption throughout this discussion is that the producer will receive much of the direct benefit of reduced transport costs. This assumption is validated below.

Current costs for various types of goods transported by truck to nearby regional markets along the unimproved road average $0.35 per ton-km, with a range varying from $0.30 to $0.54 per ton-km. This is very high and is caused by high vehicle-operating costs along the poor quality road. Interviews conducted along a road in good condition through terrain similar to that of the proposed link indicate that truck transport costs are substantially lower and average about $0.16 per ton-km. It is therefore reasonable to assume that the high vehicle-operating costs will come down after the road improvement.

The length of the road link is 28 km, and the average saving in transport cost per ton for the improved road would thus be $2.66 per ton ($0.35 per ton-km x 14 km - $0.16 per ton-km x 14 km). According to the National Transport Survey (1977) and the World Bank appraisal report of their Sixth Highway Project, truck transport in Haiti is competitive. This was also verified during our field surveys for those roads that are in good condition, and that therefore can be used even by vehicles that are not in perfect operating condition. We may therefore assume that these savings in transport costs will be passed on by the truck operators to the farmers. (Again, this was verified by interviewing farmers who lived along recently improved roads. These farmers confirmed that transport prices had indeed come down.)

The major crops grown by the farmers in the RIA consist of maize, coffee, beans, and a group consisting of tubers and plantains. As shown in Table 6, the total cultivated area of 33,000 hectares is assumed to be equally divided among these four crops. Though the actual use of the cultivated area will differ from this simplifying assumption, data were not available to enable refinement of the estimate of land utilization by each crop. It is not believed that the calculation of incremental agricultural surplus is very sensitive to the simplifying assumption of land use.

Table 6. Agricultural Production Surplus
Calculation for Link 143
(for the third year after road improvement)

Category	Maize	Coffee	Tubers (plantains & rootcrops)	Beans	Total
Area Cultivated Without Project (ha)	8,250	8,250	8,250	8,250	33,000
Area Cultivated With Project (ha)	8,250	8,250	8,250	8,250	33,000
Annual Yield Without Project (kg/ha)	800	250	4,200	800	
Annual Yield With Project (kg/ha)	840	262.5	4,200	840	
Annual Prod. Cost Without Project ($/ha)	232	119	180	840	
Annual Prod. Cost With Project ($/ha)	232	119	180	344	
Farmgate Price Without Project ($/kg)	0.290	0.950	0.090	0.860	
Farmgate Price With Project ($/kg)	0.293	0.953	0.093	0.863	
Annual Per Capita Consumption (kg/yr)	63	10	106	25.6	
Value Added ($, millions)	0.107	0.103	0.237	0.301	0.748
Surplus, With Project (kg, millions)	3.78	1.66	27.70	5.65	38.79
Local Consumption (kg, millions)	3.15	0.50	5.30	1.28	10.23

For the with-project case after road improvement, the utilization of land for each crop is assumed to be unchanged. The road influence area of link 143 has very little land that is not under cultivation.

Yields without and with the project are as indicated in Table 6. Almost nothing is known about crop yields by the small farmer in Haiti, and the limited field interviews were clearly not adequate to establish precise estimates of yields. To guard against overoptimistic agricultural productivity estimates, we assumed crop yields that are conservative, or well below what the farmers actually obtain in their fields.

For the reasons discussed above, it is judged that yields will not increase significantly through the introduction of an improved secondary road alone. However, from interviews with farmers located along recently improved roads it is reasonable to expect a reduction of about 5 percent in spoilage during transport and while waiting for transport. As discussed earlier, the reduction in spoilage was translated into a virtual yield increase, and the yields as a result of the roads improvement project alone were estimated as 5 percent higher than the yields without the project. It must also be noted that improved road access will probably induce farmers to take land used for lower value, less perishable crops (e.g., corn) out of production, and to plant instead higher value food crops (e.g., fruits and vegetables) which could be shipped to market more quickly. Incomes, therefore, may increase faster than the actual reduction of transport costs.

Production costs with and without the project were also conservatively estimated. Farmgate prices without the project were obtained by adjusting the local market prices collected during the field surveys by the transport cost before road improvement. For the with-project case, the reduction in transport cost derived above ($2.66 per ton or about 3 cents per kilo) was added to the without-project farmgate price. The resulting increase in farmgate price is very small, at most three percent for the low-cost tubers, and would by itself provide little incentive to the farmer to increase production. But this is normal for road improvement projects, in contrast to construction of penetration feeder roads where transport cost reductions of 90 percent or more can be expected. More important would be the reductions in spoilage and cost of inputs, such as fertilizer, if used by the farmers.

Finally, the per capita consumption estimates for on-farm consumption were taken from the recent AID Food and Agricultural Sector Strategy Study. Estimates of local consumption are important both for the calculation of the net incremental agricultural income as well as for estimating the vehicle requirements for transporting the agricultural surplus.

With the information presented in Table 6 we can calculate the value of the net incremental agricultural surplus (often called value added), or the money value of the increased agricultural production exported and sold at the regional market (taking into account local consumption). A well-known equation (see World Bank Staff Working Paper No. 362) defines the value added (B) as:

$$B = P_2q_2 - P_1q_1 - P_1(H_1-H_2) - 1/2\ (H_1-H_2)(P_2-P_1) - (C_2-C_1).$$

Where:

P_1 = Farmgate price (\$/ton) without project

P_2 = Farmgate price (\$/ton) with project

q_1 = Exportable surplus (tons) without project

q_2 = Exportable surplus (tons) with project

H_1 = Local consumption (tons) without project

H_2 = Local consumption (tons) with project

C_1 = Production cost (\$/ton) without project

C_2 = Production cost (\$/ton) with project

Applying this equation yields the value added for the third year (allowing for a two-year gestation period) after road improvement as $780,000 per year. Also, as shown in Table 6, the volume of the agricultural surplus after the two-year gestation period is 38,790 tons per year, or 106 tons per day. Assuming this surplus will be carried by medium trucks carrying an average of six tons per trip, about 17 one-way truck trips per day would be required to transport this surplus. The average daily traffic contributed by these trucks would therefore be double that number, or 34 truck-trips per day.

Table 7 shows the results of the economic assessment of the road improvement project. Benefits from reduced spoilage, transport cost, and user cost savings are assumed fully achieved by the third year after road improvement. After that, benefits from reduced spoilage and transport cost savings are assumed to grow at 3 percent per year, and passenger user cost savings at 6 percent per year. These growth rates assume that agricultural production will increase at 3 percent per year, and that passenger traffic will grow at 6 percent per year.

The net benefit from reduced spoilage and transport as calculated in Table 6 is shown in the first column. The second column gives the savings in passenger user costs brought about by reduced passenger transport fares. These are calculated as follows. It is estimated that before the road improvement the

Table 7. Economic Evaluation of Link 143, Carrefour Zaboca-Carrefour Charles/Roseaux (U.S. dollars)

Year	Net Benefits from Reduced Spoilage and Transport Cost Savings	Passenger User Cost Savings	Road Construction and Maintenance Costs	Net Benefits
0			484,560	-484,560
1	249,333	27,300	28,000	248,633
2	498,667	28,650	54,000	473,332
3	748,000	30,098	28,000	750,098
4	770,440	31,603	54,000	747,043
5	793,553	33,183	28,000	798,736
6	817,360	34,842	54,000	798,202
7	841,881	36,584	28,000	850,465
8	867,137	38,414	54,000	851,551
9	893,151	40,334	28,000	905,485
10	919,946	42,351	54,000	908,297
11	947,544	44,469	28,000	964,013
12	975,970	46,692	54,000	968,662
13	1,005,249	49,026	28,000	1,026,275
14	1,035,249	51,478	54,000	1,032,525
15	1,066,469	54,052	28,000	1,092,521

IRR > 50%

NPV at 15% discount ($3,677,327)

At 15%, $B/C = \frac{4,151,887}{484,560} = 8.57$

adult population in the RIA makes about 1.8 trips per year to Les Cayes/Camp Perrin or Port-au-Prince. This trip frequency is low and is, of course, due to the high cost of transportation service. The total number of trips per year before the road improvement is the product of the number of persons over 14 years of age (0.25 x 50,000) times the trip frequency (1.8). This equals 22,500 trips per year.

After the road improvement the number of trips per adult is expected to increase to at least six trips per year. These estimates were derived from knowledge of the passenger trip frequencies in other developing countries (in the Philippines, for example, trip frequencies increased from between 14 to 45 trips per thousand population before the road improvement to 56 after improvement), and from interviews with the farmers along a number of good and bad secondary roads in Haiti.

Passenger fares are expected to decrease from the current rate of 7 cents per passenger-kilometer to 3 cents per passenger-kilometer after the road improvement. Applying the equation for benefits from normal and generated traffic where the latter is assigned one-half of normal traffic benefits we obtain:

Annual passenger user cost savings = $1/2\ (Q_1+Q_2)\ (C_1-C_2)$

Where:

Q_1 = Annual trips before road improvement

Q_2 = Annual trips after road improvement

C_1 = Passenger transport cost before road improvement

C_2 = Passenger transport cost after road improvement

Since the road is 28 km long and, on the average, passengers will travel half this distance, the cost difference between the with-project and without-project road improvement cases is (\$0.07 x 14) - (\$0.03 x 14) = \$0.56. Q_1 equals 22,500 trips per year and Q_2 is 75,000 trips per year. Applying the above equation yields the user cost savings of \$27,300 per year. As indicated in Table 7, this is assumed to grow along with the traffic at a rate of 6 percent per year.

3. <u>Road Reconstruction and Maintenance Costs, Link 143</u>

The project road is 28 km long and is part of the road linking Les Cayes to Jeremie. It is a gravel-surfaced road in mountainous terrain, and has an average 4-meter width. Proposed rehabilitation consists of digging longitudinal ditches along the road on the mountain side, laying pipes for transverse drainage, regrading the wearing surface for smoothness, and widening the road every 300 meters for turnouts and bypassess.

Rehabilitation, averaging a total of 3 km per month, would be carried out by two light brigades.[13] Approximately three pipe culverts will be needed per kilometer for transverse drainage. The wearing surface would be recharged with a 15-centimeter layer of pit-run material. Most of the earth-retaining structures are dry-laid rock walls which will not be upgraded to masonry walls or removed because they are deemed satisfactory in relation to traffic volume. Hence, heavy equipment must not be used on this type of rehabilitation. Again due to the low volume of traffic, general widening of the road in not considered.

Table 8 provides the cost estimate for this rehabilitation project. Routine maintenance cost is assumed at $1,000 per kilometer for each year, and periodic maintenance cost at about $2,000 per kilometer for every two years. The road improvement and maintenance costs are shown in column four of Table 7.

4. Results of the Economic Assessment of Link 143

As shown in Table 7, the internal rate of return of the link exceeds 50 percent, and the benefit/cost ratio calculated at a discount rate of 15 percent is well above unity. In fact, the road improvement cost could be tripled by widening the road or applying a better pavement, and the improvement would still be feasible. However, although every effort was made to keep the economic analysis conservative and to guard against overoptimism in forecasts, the analysis still includes the risk that costs and production forecasts may be off the mark. The best policy, therefore, is to adhere to the "staging" approach where the road is improved to minimal standards and the buildup of traffic is closely monitored. If the impact of the road later materializes as expected, the road can then be further improved at only a slight increase in cost (because of discounting) over what the cost would have been had the improvement been incorporated at the outset. If the impact of the road does not

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[13] A light brigade consists of about 250 unskilled laborers equipped only with handtools, though some compaction equipment and trucks may be available.

materialize as rapidly as expected, the road can be left as it is. The cost of overdesign is thereby avoided.

Table 8. Cost Estimate for Rehabilitation of Road Link 143

Item	Quantity	Unit	Unit Cost	Total Cost
Longitudinal Drainage	28	Km	$6,000	$168,000
Transverse Drainage	84	Pipe Culvert	850	71,400
Surface Recharging	28	Km	5,500	154,000
Widening	93	Units	800	74,400
Subtotal				$403,800
Contingency				80,760
Total				$484,560
Cost per km:				$17,300[1]

[1]Unit costs have risen substantially since this estimate was established.

Source: Unit costs were obtained from the Office of the Agricultural Feeder Program Project.

V. IMPLEMENTATION

Selection and justification of rural roads will require a substantial effort. As explained earlier, however, little is known about what the optimum level of effort should be, although it was pointed out that it is probably better to spend too much on this task than too little. In this report, we will provide only an indication of what a reasonable level of effort would be for the selection and justification of roads in a typical low-volume rural roads project. This level of effort will exclude the cost of detailed engineering which, in fact, may not be required for most low-volume rural roads projects.

Implementation of the selection and justification process will involve the following tasks:

1. Identification of screening criteria, the relevant evaluation factors, and factor weights
2. Field data collection for the screening and ranking
3. Screening, Phase I
4. Socioeconomic ranking, Phase II
5. Field data collection for economic assessment, Phase III
6. Calculation of the economic rate of return, Phase III.

A. Screening Criteria, Factors, and Weights

Identification and discussion of the screening criteria and the evaluation factors for the socioeconomic ranking should, ideally, occur during the Project Identification Document (PID) preparation. This discussion is an essential element in the development of the project objectives. Development of the factor weights can take place early during the Project Paper (PP) phase.

Development of the screening criteria and evaluation factors should not require a great expenditure of time and effort. Essentially, a useful collection of these factors has already been proposed in the previous chapter. It may be, however, that the requirements of the project demand inclusion of special factors. For the Haiti Secondary Roads Project, for example, the special factor of regional preference had to be introduced.

The development of the factor weights using a consensus mechanism such as the Delphi process should be done early during project implementation, and can be done concurrently with the field surveys. Though AID has had little experience with the Delphi process, it should be possible to complete the task in three weeks. The AID program manager, or a consultant, should be actively involved during this phase, and should be expected to spend about one-third of his/her time on this task. In addition, one-half day each may be required from the 10 or so participants in the Delphi process.

B. Field Data Collection for Screening and Ranking

The collection of the field data required for screening and those required for socioeconomic ranking can be done together. Based on earlier experience, it is estimated that for the average 15-km road, this data collection should require one-half day of effort by a one- or two-person team, provided the road is passable for vehicles at the time of the survey. If the road is not passable or the vehicle is in poor condition, the time required for the survey could increase to two days. On the average, we will assume that one day is required per road. Screening of the roads can be done on-site.

For a typical rural roads project consisting of 700 km of roads with an average length of 15 km per road (47 roads), and assuming one day is required per road by a two-person team recruited locally or from the staff of the participating agency, the total survey time would be 47 working days (three calendar weeks if three teams are used). Assuming a cost of $200 per person per day, the cost of this field survey phase would be 47 days x 2 persons per day x $200 per person/day = $18,800, or approximately $20,000.

C. Socioeconomic Ranking

Tabulating the field data and calculating the ranking scores could be done in one week by two clerks, and is not a significant task from the point of view of preparation cost.

D. Field Data Collection for Phase III

Though it may be more efficient to collect the field data for Phase III at the same time the data for the screening and socioeconomic ranking are collected, it will be assumed here that a separate effort is necessary. The best time to collect these data will depend on the particular project. If it is believed that many of the candidate roads will be eliminated during the screening and ranking phase, it would be wasteful to collect the detailed data required for Phase III for roads that will be eliminated. On the other hand, if transport to the project areas is costly, it would be wasteful to have to make two trips where one trip would have sufficed.

To provide a conservative estimate of the cost of project preparation, it will be assumed that the Phase III data will be collected during a field survey. It is estimated that about two days will be required by a three-person team for each road, and that 20 percent of the candidate roads will be eliminated during the earlier phases. The survey cost would therefore be as follows:

> 0.8 x 47 roads x 2 days per road x 3 persons per team x $200 per person = $45,120, or approximately $50,000.

With three teams, the calendar time required would be as follows:

$$\frac{0.8 \text{ x } 47 \text{ roads x } 2 \text{ days per road}}{3 \text{ teams x } 5 \text{ days per week per team}} = 5 \text{ weeks}$$

E. Analysis of Field Data and Economic Justification

With a microcomputer or an advanced programmable calculator. a transport economist would require about one-half day per road to do the economic justification. The cost would be one-half day per road x 0.8 x 47 roads x $200 per day = $7,520, or approximately $10,000. In total, the cost of the preparation phase would be about $20,000 + $50,000 + $10,000 = $80,000. We may double this to take into account any factors that might have been ignored and other contingency factors, resulting in a preparation cost of about $160,000. Since the total number of kilometers of roads that would be constructed would be about 0.8 x 700 = 560 km, and assuming that the construction cost would be about $25,000 per kilometer, the preparation costs would amount to slightly more than 1 percent of the total cost of the project. (This percentage is quite low considering that detailed engineering for primary and secondary roads costs between 5 and 10 percent of the road construction cost.)

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